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Determinants of Social Security Pensions Expenditure in Portugal

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Abstract

In most European countries Social Security (SS) systems are characterized as Pay-as-you-go systems. Their sustainability is being challenged with demographic changes, namely population ageing. Portugal's population is ageing rapidly being one of the countries where this problem is more critical. With the growing debate on this topic several public choice models have been developed so as to explain SS size. In this work project there is an attempt to understand whether these models contribute to better explain Social security expenditure with pensions (SSEP) and to establish the need of finding ways to reduce present commitment with pension expenditure in Portugal.

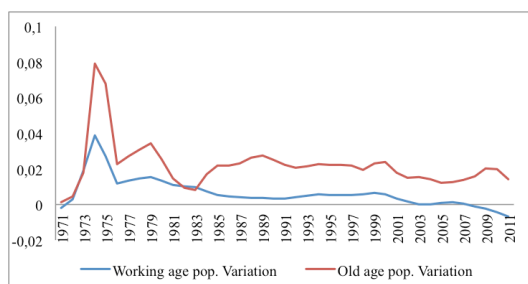
Key Words: Social Security; Population Ageing; Public choice theories;

1. Purpose of the Project

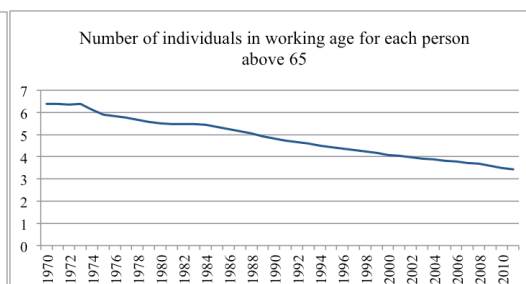
Retirement is a relatively recent concept. In 1883 German Chancellor Otto Von Bismarck implemented the first welfare state in the World, as a response to the rise of new political ideologies (socialism) in Europe. The initial retirement age was 70 and was revised to 65 in 1916. Pensions were adopted all over the world not only as a political need but also as a social one: the few people that would live until 65 would have severe difficulties in working and would not be able to sustain themselves.

The retirement age was maintained for almost a century but population and social structures changed considerably, leaving several European systems in distress. Portugal is no exception, as the system in place is the Pay-as-You-Go-System (Paygo), that is highly affected by demographic changes.

The Portuguese elderly population increased every year more than younger population since 77. Also one should note that it has never decreased in this period, unlike younger population. This can be observed in the first Graph. Furthermore it has direct influence on the ratio of population in working age over population above 65. On Graph 2 shows the decline of this ratio since 71. In 40 years this number has decreased from 6,4 to 3,4. If one considers the OECD Population estimates, there will be a further fall, reaching 1.75 in 2060, roughly half of 2011 values; this means that for each person in retirement age there would be less than 2 in working age.



Graph 1: Population annual variation
Source: PORDATA and author calculations



Graph 2: Population above 65 over working aged population

The Paygo system so widely spread in Europe must suffer some changes in the close future. Portugal's retirement age will increase next year to 66 and should reach 67 in

2029. Also, some sustainability components were added to the pension calculation. Nevertheless there is a rapid upward trend in population ageing and hence these measures only postpone the inevitable Social Security Deficit. This was made clear by the government proposal.

Several public choices models have been made in order to understand the size of social security systems in the western world. The scope of this project is to debate some of these hypotheses and try to study their implications in a time series methodology so as to understand which one better fits in the Portuguese framework. To do so, the SS system is first introduced, followed by the Literature Review and Competing Hypothesis presentation on section 3. Then variables will be studied on section 4 and theories will be tested on 5. Finally, section 6 concludes de project.

2. Social Security Framework

2.1 – Three pillars of Pensions

Pension systems are divided in several different ways regarding the sources of pensions. Traditionally they are divided into three different pillars:

- 1) Public Pensions refer to the public mandatory system. The coverage of this system varies from country to country and can range from the sole protection of workers to the protection of all citizens. Alternatively one can define the first pillar as non-contributory or basic pension having the sole purpose of guarantying a minimum income.

- 2) Occupational Pensions that encompasses an individual complementary protection to worker groups and pension funds. Furthermore it can be defined as the compulsory savings contributory pillar instead.

- 3) Personal pensions that refers to individual savings for retirement purposes.

This in Portugal includes Retirement Savings Plans (PPR's). According to the

World Bank *Averting the Old Age Crisis* Report this can be called the voluntary savings contributory pillar.

In Portugal the thickest pillar is the second, as most retirements are occupational: Only one third of the beneficiaries have a disability or survival pension. The third pillar, that is own savings, has still small representation.

2.2 - Pay as you go Systems

Portugal's System can be defined as a Pay-as-you-go system (Paygo). Traditionally run by the government, Paygo are based on the fact that it is possible to tax current workers in order to ensure pensions for last generation workers. In a Legislative perspective there is a contract between the system and the worker assuring the second that if he pays contributions today he will receive a retirement pension in the future. From a macroeconomic perspective there is a simple transfer of revenues from one group to another. Nonetheless the objective is clear: intergenerational redistribution that result in risk sharing across generations.

Following Samuelson (1958) and Aaron (1966) one can say that Social Security Paygo can increase welfare if the population growth rate summed by the productivity growth rate is higher than the real interest rate.

2.3 - Political evolution of the system

Currently, besides a lower bound of roughly 200 euros per month, the calculus to determine pension benefit value is a function of the number of years of work, the average wage of the last 10 years of working life, the retirement age and inflation. All these factors influence positively the amount received. Moreover other factors influence how generous benefits actually are: Eligibility for example.

There have been several policy changes that have affected Social Security Expenditure with Pensions (SSEP) or SS revenues either by changing benefits or

contributions calculations or by changing entitlement to these benefits. It is important, for the purpose of this analysis, to understand these structural changes on Social Security policy. To do so major changes that impact directly on pension system and distribution are listed as follows:

In 1974, as a result of great political changes in Portugal, a more socially protective policy was implemented in the context of Social Security. Not only pensions eligibility was widened to include pensions for disabled people for example, but also the unemployment subsidy was created. This change is highlighted by the 1976 constitutionalization of the right to Social Security. This can be seen as a first attempt to further establish the first pillar of SS.

In 1980 a non-contributory regime of social protection, for poorer citizens was created. Six years later the TSU (single social tax) was created. Furthermore farmers were also included in the pension general scheme. In 88 the unified pension regime was established. Then, in the early 90's legal changes on pension funds were made and pre retirement regime was instituted. The 93 political reform promoted big changes to pension calculations for both old age and disability pensions. Also a social complement, without contributory basis was created. In 96 the minimum guaranteed income was created for the non-contributive regime, together with a social inclusion program. The fundamental objectives of SS reform were established in 2000, these were: the improvement of social security protection levels, guarantying financial sustainability of SS system and management efficiency improvement. Changing pension calculation and SS financing sources would fulfill these objectives.

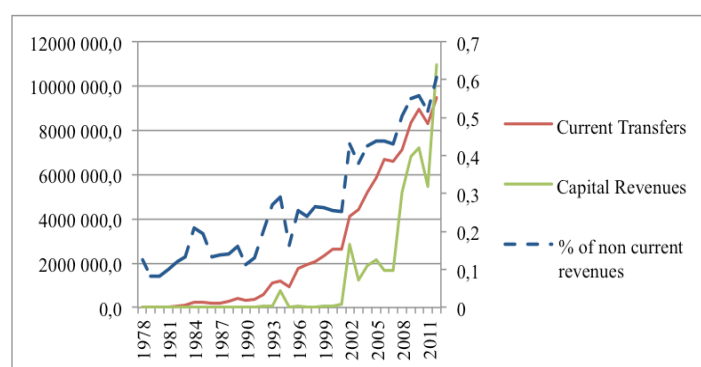
In 2003 the new SS basis Law went in to action, which led to a change in the system architecture. There was a division of three main systems within the SS framework: the public system, the social action system and complementary system. Furthermore

calculations of several pensions, subsidies and complements were changed. 2007 amendment created some incentives to prevent early retirement as a sustainability factor was added to the calculus, reducing in this way pension benefits when people work fewer years. Other smaller changes were made to pension benefits calculations. Finally, in 2012, further rules were implemented to decrease the incidence of early retirement. In the past year there were several retirement benefits reductions: Current economic crisis is resulting in massive cuts in all social spending. Nevertheless, not only there are social constraints to reduce benefits but also there are several legal constraints. Even though Portugal is currently experiencing a difficult economic time, and Troika is being used as a scapegoat, these changes are being made against public opinion.

2.4. Social Security Pension systems in Portugal development

In a Paygo system there is a direct interaction between expenditures with pensions and contributions. However SS Revenues (SSR) are not completely explained by contributions, actually there are several other income sources. Currently, revenues other than contributions surpass 60% of SSR. Two of the main sources are depicted in the following chart. The

weight of Current transfers, Capital Revenues and Capital Transfers on SSR are represented in blue and should be read using the

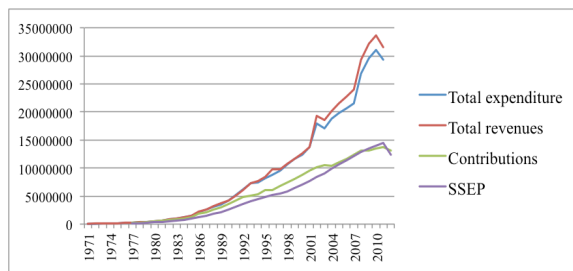


secondary axis.

Graph 3: SSR Structure; Source: Pordata

Revenues have been increasing considerably but so is SS expenditure, both with pensions and other subsidies such as unemployment benefits. The chart on the left

shows total expenditure and revenues together with Contributions and SSEP. Both pairs have followed a similar path and it was only in 2009 that SSEP surpassed contributions, however this was amended in 2012 with the significant decrease of pension expenditure resultant on major cuts in pension benefits.



Graph 4: SS Expenditure and Revenues; Source: Pordata

One can say that contributions are a function of number of workers, average gains and tax rate. Number of workers is expected to decrease considerably in

the future, actually in light of OECD

estimated working age population will decrease roughly 16% from 2010 to 2060. Furthermore a 57% increase in population over 65 is expected from 2010 to 2060. Substantial productivity gains together with increasing tax and employment rates are necessary to offset this tendency let alone follow the growing tendency of pension expenditure.

3. Literature review – Competing Hypothesis

There are several theoretical public choice models that try to explain social security size. Lindert (1996) divided these public choice theories into 6 main hypotheses: deadweight costs, bureaucratic momentum, electoral variables, age distribution, income level and income asymmetry. Here the focus will be set on the last three hypotheses.

The age distribution of the adult population is probably one of the main influences on retirement welfare programs size. Demographic changes are the most crucial factor that have been endangering Pay-as-you-go systems in Europe: the increase of the number of beneficiaries, ceteris paribus, will lead to an increase of SS size.

It is important to note however that what happens to the generosity of the system is not transparent. On one hand in an ageing population the number of pensions granted in a system like the Portuguese is bound to increase, augmenting in this way the bargaining power of elderly people, but on the other hand the number of contributors will decrease increasing the burden with pensions.

As an attempt to understand this, John Turner's (2001) model of intergenerational transfers shows that the old age and youth dependency ratios can be seen as shadow prices of social security pensions transfers and intergenerational transfers to the young respectively. Bearing this in mind he believes that ageing population will lead to an increase in overall pension expenditure but benefits will decrease relative to earnings. This is because political power gained by increasing elderly population is offset by the increase in the shadow price of benefits.

Income growth has been associated not only with the increase of SSEP but also in its share of National income. In Portugal in the last 40 years it has increased from less than 1% to almost 8%. Nevertheless the underlying reason for this to happen has still to reach a consensus. Lindert describes it as the "most durable black box in the whole rise-of-the-state literature" and thus it should not be included formally as a public choice theory. Consequently, this statistical relationship will not be studied as a hypothesis but as an attempt to understand its genesis.

Income distribution theory departs from the fact that inequality has been related with higher preference for redistribution and therefore taxation. The theoretical reason underlying this hypothesis is that the median voter would prefer more taxation the poorer he is in relation to the average income. Tabellini (1990) developed the first model that explores this idea, defending that the political support of current social security programs are due to the fact that they redistributes both across and within

generations. If this is true then some policies such as SS privatization would imply greater costs than the ones analysed, as privatization would considerably decrease redistribution.

However, recent studies have shown that intragenerational redistribution has been decreasing over the last 20 years. Krieger and Traub (2008) study this hypothesis empirically using the Bismarckian factor¹. Even though statistical evidence is weak, it was observed for the past 15 years an increase of both the Bismarckian factor and the generosity of the pension system.

Borck (2007) noted that if life expectancy is correlated positively with income then it is possible that policies designed to be progressive could even be regressive, “if the longer life expectancy [of higher income population] more than outweighs the higher contributions”. Therefore, if we truly have redistribution, income inequality would lead to higher pension levels.

It is of interest to mention electoral variables hypothesis as it is reasonable to assume that *political agenda* has a great influence on welfare spending. In fact what really determines the benefits amount and pensions eligibility is policy making. As governments design benefits the increase of social spending is normally associated to a political agenda. Some theoretical attempts to study political agenda impact on SS expenditure have been made. Most of these efforts are translated in voting models that generally assume that voters are selfish.

In a general equilibrium framework Cooley and Soares developed a voting model to study the political possibility of *Privatizing Social Security* (1999). Not only the short run financing problem, but also the fact that the Paygo system is politically robust

¹ “The Bismarckian factor divides the pension benefit into a flat component (such as a basic or minimum pension) and into an earnings-related component: the higher the Bismarckian factor, the more important is the earnings-related part and, thus, the smaller is the degree of intragenerational redistribution.” Empirically it is the “ratio of the income share of public pensions in the bottom quintile to the same share in the top quintile” Krieger and Traub, 2008

makes it hard to change. They attempt to design a transition phase that maximizes political support in a general equilibrium framework. All policies that would be feasible include a great increase of public debt.

There have been made several empirical studies that attempt to explain SSEP. To understand which series were used in the literature the table that follows summarizes these models that study social security expenditure. Next to the independent variables there is an indication² of their effect on the bold dependent variable.

Dependent variables	Independent variables		
	Income inequality	Demographic	Economic; Political; Others
Tabellini Welfare+SS expenditures	Top 20% over Low 40% inc.(+)	Proportion of 65+ in total population (+)	
Breyer and Craig			
SS contributions % GNP	Gini coefficient (?)	Ratio (40-60) over (65+)(-)	L-run real interest rate(-)
Benefits as % GNP		Median age(+)	L-run real growth rate (+)
Pensions (government) % GNP		Portion households 1-4(+)	Inflation rate (+)
Ben. p/person60+% GNP			Log Real GNP pc (?)
Lindert			
All gov. expenditure	ln(up. inc. gap) (+)	School-agers (+)	ln(Gdp per adult 20-64) (-)
Non-social expenditure	ln(low. inc. gap)(-)	Young adults (+)	Voter turnout (+)
All social expenditure	Inc. inequality= ln(up)+ln(lower)(-)	Over 65's (+)	Executive turnovers(+)
Pensions expenditure			
Other 4 Social exp.	Income skewness = ln(up)-ln(lower) (+)		
Unemployment expenditure			
Education expenditure			
Health expenditure			
Turner Average pension Benefit		Old dependency(+)	Earnings (dual effect)
Both in log(**) and not		Youth depend. (+)	SS coverage ratio (-)
		Working pop(+)	Benefit Eligibility (+)
		Labour force part. Rate (-)	Benefit acceptance (+)
		Employment rate (+)	
		Old age pop (65+) (+)	
		Youth Pop (+)	
Krieger and Traub			

² (+) or (-) if the variable has a positive or negative impact respectively. (?) Denotes the cases in which the effect is not clear.

Bismarckian factor	Inc. Skewness(-)	Life expectancy(+)	Mean income(-)
Generosity index		Household Size(+)	Inc. Coef. of Variation(-)
José Correia		Beneficiaries (+)	GDP (+)
SSEP		Population (+)	Social Contributions (+)

Table 1: Summary of SS expenditure explanation models in the Literature

4 – Stationary Analysis: The Fourier Transformation Model

The first step to study time series variables empirically is to determine if they are stationary or not. Note that, as most of SS variables are subject to structural shocks applying standard linear tests can lead to biased results. The introduction of dummy variables to test stationarity is tempting but it raises big issues. Although one can pin point most of these shocks, their inclusion would result in a problem of pre-selection. Furthermore Dummies will account for a sudden break, and therefore will not fit properly in most data and would result in power loss, something to be avoided when we have so many shocks and so little data.

An alternative to simple linear model is to use a Fourier function. This, according to both Enders and Lee and Becker *et al.* is able to mimic a large variety of breaks in the trend function. Also note that it is possible to introduce a more general Fourier form, but this may lead to over fitting issues, and power losses.

In a linear framework, so as to perform both Dickey Fuller test and the Augmented DF, one should run the regressions:

$$1) \Delta Y_t = \theta + \alpha y_{t-1} + \beta \Delta y_{t-1} + \delta t$$

$$2) \Delta Y_t = \theta + \alpha y_{t-1} + \beta \Delta y_{t-1}$$

On a first approach both these tests were performed for all studied variables. To choose the Lags on the ADF test partial autocorrelation (pac) and information criteria were used. In annex it is possible to observe test results, AC, PAC graphs and Information Criteria tables.

When including the non-linear framework the regressions to be run are as follows:

$$3) Y_t = \theta_0 + \beta_0 y_{t-1} + \delta t + \alpha_1 \sin(2k\pi t/T) + \alpha_2 \cos(2k\pi t/T), t=1, 2, \dots, T$$

$$4) Y_t = \beta_0 y_{t-1} + \alpha_1 \sin(2k\pi t/T) + \alpha_2 \cos(2k\pi t/T), t=1, 2, \dots, T$$

Where T is the sample size and K is a parameter that denotes frequency. K should be estimated for each variable to be studied and then fixed. To do this one should first run equations 3) and 4) by setting $\beta_0=0$ for each possible 5 k's. Then the value of k that provides a better fit for the variable should be set. Note that when the frequency gets bigger the breaks will be occurring really often.

After choosing the appropriate K, for both equations, equations 3 and 4 were regressed, followed by testing it as suggested by Enders and Lee. A normal t statistic is performed to test the null hypothesis $H_0: \beta_0=1$ against the alternative $H_1: |\beta_0|<1^3$. Enders and Lee Critical values can be found in Annex, together with the regression tables of the estimated equations.

4.1 - Contributions

After performing ADF tests it was concluded that contributions is a unit root. To further test this variable a Fourier transformation was performed. The first step was to choose the appropriate frequency. In the following table, adjusted R-squared values can be observed for different values of K. K was set as 1.

	K=1	K=2	K=3	K=4	K=5
R2 W. trend	0.9869	0.9854	0.9834	0.9857	0.9796
R2 W/out trend	0.8780	0.0583	0.0004	0.0063	0.0253

Table 2: Frequency determination

Then the test was performed. Results are as follows:

Average Benefits	Test Statistic	1%	5%	10%	Conclusion
No trend	-0,09	-4.69	-4.10	-3.82	Unit Root
Trend	-3,365	-4.69	-4.10	-3.82	Unit Root

Table 3: Tests statistics and critical values for the DF test of the Fourier transformation equations

The variable is a unit root process. This means that a shock, either positive or negative, will have long lasting effects on contributions. For this variable shocks can

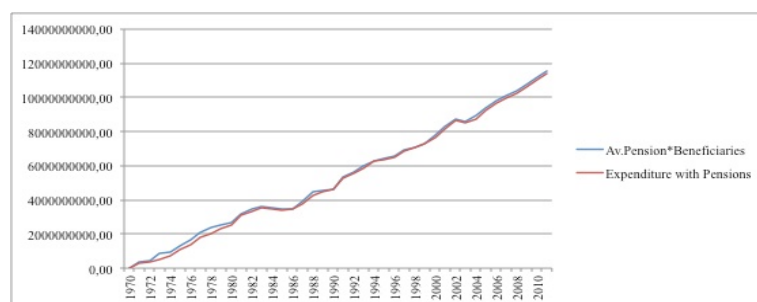
³ Test Statistic= $(\beta_0-1)/Se(\beta_0)$

have a number of different sources, such as the ones pinpointed above: number of workers, average gains and SS tax rate (TSU).

4.2 – Social Security Expenditure with Pensions

Pension expenditure is influenced by two main factors: the number of pension beneficiaries and average pension benefits, (APB⁴). As stated before the number of beneficiaries is expected to increase considerably which stresses the need to increase revenues or decrease average benefits.

The following chart represents in red real expenditure with pensions and in blue real average pensions times the number of beneficiaries.



Graph 5: APB times beneficiaries and Expenditure with pensions

After performing ADF tests it was concluded that SSEP is integrated of order 2 (see in annex). In order to have a meaningful analysis of this variable as a whole, it is of interest to study each component that characterize it individually.

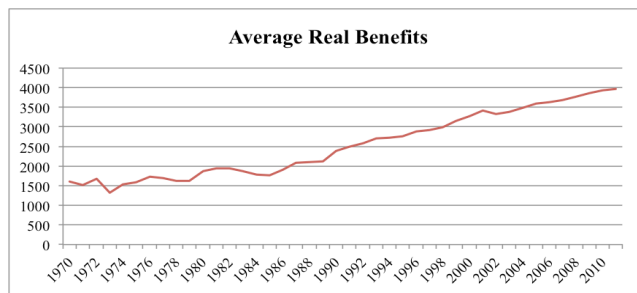
Number of beneficiaries is a demographic variable that theoretically should be characterized as a unit root (retired people would be explained by retired people in the last period almost perfectly). ADF tests confirmed it, but it will be further debated in the segment “age distribution theory”.

4.2.1 – Real Average Pension Benefits

In the event that real benefits would present a somewhat stable behaviour, changes in SSEP would be explained simply by changes in the number of beneficiaries, that is,

⁴ In this Work Project all monetary value variables are treated in real terms discounted with 2006 GDP deflator. Although some variables would make sense to be discounted by the CPI, the deflator was used always, so as to have a coherent analysis overall.

demographic changes. But in fact in the last 40 years there has been a considerable increase on real average retirement benefits.



Graph 6: Real APB; Source: Pordata and author calculations

Considering this chart, it is quite straightforward to assume that one should take into account other public choice theories other than age distribution to explain SSEP:

It is not only the number of beneficiaries that affect Expenditure with Pensions.

Again a stationarity analysis was performed and in all tests (ADF) average pension benefits failed to reject the null of non-stationarity. This was followed by the Fourier transformation analysis. First the K was set as 1:

	K=1	K=2	K=3	K=4	K=5
R2 W. trend	0.9876	0,9622	0,9567	0,9605	0,9567
R2 W/out trend	0.7007	0.0987	0.0714	0.0282	0.0225

Table 4: Frequency determination

Then the regression tables and test statistics were run. The following table presents the results:

Average Benefits	Test Statistic	1%	5%	10%	Conclusion
No trend	-0,133	-4.69	-4.10	-3.82	Unit Root
Trend	-3,602	-4.69	-4.10	-3.82	Unit Root

Table 5: Tests statistics and critical values for the DF test of the Fourier transformation equations

This means that a shock on average pension benefits will not fade away, having in this way long lasting consequences. It is therefore of outmost importance to understand what can translate in changes on APB. Given data limitations, testing simultaneously all public choice theories would lead to serious power losses. For this reason each theory will be studied individually.

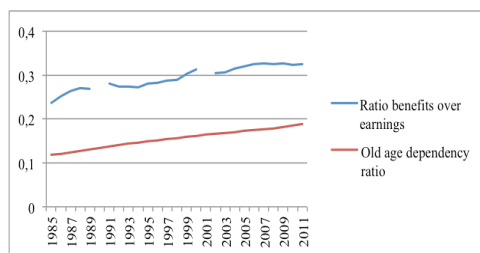
5 – Public choice hypothesis

5.1 – Age distribution theory

The importance of age distribution in SSEP is so straightforward there is no need to

linger too much in explanations: Everything else constant, the increase of pension beneficiaries will lead inevitably to an increase in pension expenditure. This would not be problematic, if young population would also increase so as to maintain a similar age distribution or productivity rises considerably. The only policy instrument to affect this number directly is to change the legal retirement age. Nevertheless it is possible to change it indirectly with fiscal incentives to work longer for example.

Other analysis of interest is the effect of number of beneficiaries on average benefits. Actually, in light of Turner's model, benefits should decrease relative to earnings. To understand this relationship a chart representing old age dependency ratio and average benefits over average income is presented below:



Graph 7: Ratio Benefits/earnings and dependency ratio; Source: Pordata and Author Calculations

Benefits have been increasing relative to earnings since 85 opposing Turner's theory.

Still, this can merely indicate that old dependency ratio is still not high enough for this relationship to be of political significance,

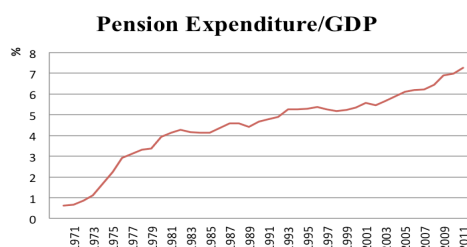
that is, the benefit's shadow price is still not high enough to offset the elderly bargaining power gain. Therefore no conclusion can be drawn on Turner's theory from this analysis, although one can state that, at this point, there is no evidence to support it.

5.2 – Income growth “theory”

Even though income growth should not be labeled as a “theory” it is of interest to understand the genesis of this relationship and if it is causal. To properly study this, it is important to analyse carefully the implications of each variable that can explain the evolution of pension expenditure when compared to income growth. In this project the focus will lay on two ratios: SS pensions spending over GDP and Average

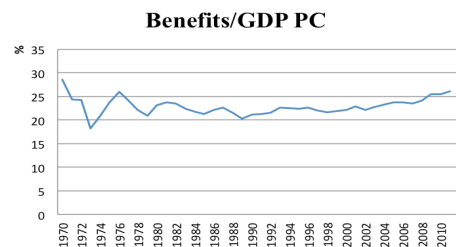
pension benefits (APB) over GDP per capita. In addition, also the comparison between APB to average income will be analysed.

SSEP as a percentage of GDP has grown considerably in the past 42 years. As stated before, the underlying reasons for this phenomena, (observed all over the world), are yet to be determined. Although the overall expenditure when compared to GDP has been increasing, the fact is benefits have been increasing in a somewhat proportional fashion to GDP per capita. The chart on the right represents the ratio APB over GDP per capita. It has been fairly constant, especially since the late 70's.



Graph 8: SSEP/GDP

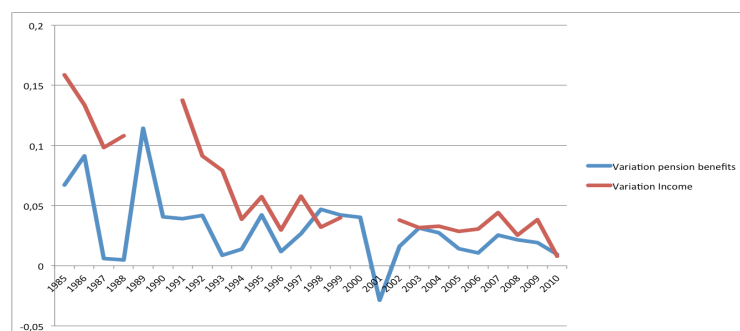
Source: Pordata and author calculations



Graph 9: Benefits/GDP per capita

The main difference on these indicators is of course age distribution. Population increased considerably in the last 4 decades but old age pensioners increased more than proportionally. Furthermore although benefits increased proportionally to GDP per capita, beneficiaries increased in number and in percentage of total population.

Another important comparison to be made is about average pension benefit variation and average income variation. Although average pension benefits have had a positive real variation, they have been increasing less than average income for almost all the period since 85. The following chart represents simultaneously both variations.



Graph 10: APB and income variations; Source: Pordata

This analysis is still too superficial to be conclusive. To further analyse the variables the first step is again infer on the variables stationarity.

After performing ADF tests on Pensions expenditure over GDP it was concluded that it is a non-stationary variable: In all scenarios the test failed to reject the null of unit root with exception of the trend stationary test with more than 3 lags (PAC and information criteria suggest 2 lags), see in annex. Although there was some evidence that the series is trend stationary detrending the series held non-stationary results. Therefore this evidence is not strong enough to be considered.

To further test this hypothesis a Fourier transformation approach was made. To do so, the frequency was chosen followed by regression of equations 3) and 4).

	K=1	K=2	K=3	K=4	K=5
R2 W. trend	0.9814	0.8961	0.9146	0.8960	0.8963
R2 W/out trend	0.3958	0.1964	0.1526	0.0601	0.0429

Table 6: Frequency determination

Then test statistics were assessed and compared to critical values. This can be observed in the following table and regression tables are available in annex.

SSEP/GDP	Test Statistics	1% Critical Value:	5% Critical Value:	10% Critical Value:	Conclusion
No trend	-0,072	-4.69	-4.10	-3.82	Unit Root
Trend	-1,973	-4.69	-4.10	-3.82	Unit Root

Table 7: Tests statistics and critical values for the DF test of the Fourier transformation equations

The conclusion is clear – the variable is a unit root. Furthermore it is integrated of order one, as when differenced it becomes stationary.

The same analysis was made regarding benefits over GDP pc. Again K was set as 1 and there is evidence that this variable is a unit root:

APB/GDPpc	Test Statistics	1% Critical Value:	5% Critical Value:	10% Critical Value:	Conclusion
No trend	-3.001	-4.69	-4.10	-3.82	Unit Root
Trend	-2,881	-4.69	-4.10	-3.82	Unit Root

Table 8: Tests statistics and critical values for the DF test of the Fourier transformation equations

So a positive shock in benefits over GDP per capita and in total expenditure over

GDP will have permanent effects respectively.

It is dangerous to draw conclusions from these results regarding income growth “theory”; nevertheless some things can be said: Average income has grown more than average pension benefits and GDP pc has followed a somewhat similar path as benefits. Is it possible that the relation between SSEP and GDP can be a result of purely demographic changes and not income growth per se? Actually the following inequalities indicate that income growth “theory” has a demographic basis:

$$5) \Delta GDP < \Delta(\text{Total Expenditure})$$

Given past reasoning ($\text{Total expenditure} \approx \text{APB} * \text{Beneficiaries}$) and a simple linearization one can simplify:

$$6) \Delta(\text{Total Expenditure}) \approx \Delta(\text{APB} * \text{Beneficiaries}) \approx \Delta \text{APB} + \Delta \text{Beneficiaries}$$

Therefore:

$$7) \Delta GDP < \Delta \text{APB} + \Delta \text{Beneficiaries}$$

If $\Delta GDP > \Delta \text{APB}$, then income increased more than benefits and the relation GDP over total expenditure has increased so much on account of $\Delta \text{Beneficiaries}$.

Calculating these variations between 1974 and 2011 the equation above can be translated in:

$$8) 2,35 < 1,47 + 2,78$$

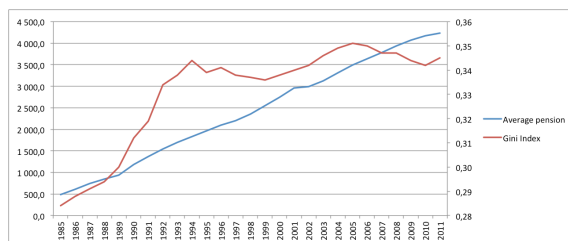
In fact GDP has increased more than APB. Although policy makers should be careful so as to revert the increasing tendencies of SSEP over GDP, there is evidence that this relationship is explained simply by demographic changes in Portugal.

5.3 – Income distribution

Tabellini’s SS model concludes that “*The size of the social security program is larger i) the greater is the proportion of retired individuals in the population; and ii) the greater is the inequality of pre-tax income*”. In his 90’s paper, Tabellini used cross-

country comparison, (panel data) to prove his theory. In this case, as the focus will be set on the Portuguese case, only time series data will be used.

Unfortunately data availability of inequality measures is very limited in Portugal and only data from 1985⁵ onwards was found. To measure inequality the post tax Gini index was used. This index varies from 0 to 1 where 0 represents a scenario when all wages are equal and 1 when one person has all the income and the remainder population has nothing. So when this indicator increases so does inequality and one should expect an increase in the real average pension value. When analysing the chart one can see that the variables share a positive tendency.



Graph 11: APB Gini Index
Source: Pordata and author calculations

```
. corr tot_expenditure av_pension gini proportion_old
(obs=27)
```

	tot_expenditure	av_pension	gini	proportion_old
tot_expenditure	1.0000			
av_pension	0.9957	1.0000		
gini	0.7966	0.8403	1.0000	
proportion_old	0.9873	0.9953	0.8637	1.0000

Table 9: Correlation table

Furthermore, this tendency is also observable in the correlation table on the right.

Actually Gini index is positively correlated with total pension expenditure and average benefits. This does not mean that the relation between these variables is not a spurious one – that is, although they follow a similar time path they do not have a casual relation.

We have seen that average benefits is integrated of order one. Furthermore Gini Index and proportion of old people are also $I(1)$ variables, tests can be found in annex. Regular regression analysis is therefore off the table; to properly study these variables one should use first differences even though this would lead to a great amount of information loss. However if the variables have a cointegration relationship, there is a meaningful long-term relation among the variables and not a spurious one.

⁵ Rodrigues, C; Rodrigues R; Junqueira V. 2010. “Desigualdade económica em Portugal”, Fundação Manuel dos Santos And Pordata, also from the same fundação

A cointegration relationship exists when the residuals of a linear combination among variables with the same integration order are stationary. This can be seen as the long run structural relationship among variables.

The most common test for cointegration is the Engel Granger approach. If we have a balance regression one should first run it by OLS and preserve the residuals. Then test the residuals for unit roots that is, using an Augmented Dickey Fuller test to check whether they are stationary or not. If the null is rejected then there is a cointegration relationship among the variables. It is important to notice that, as the variable to be tested is an estimated time series the usual critical values for the ADF do not apply. In the present paper critical values estimated by James G. MacKinnon⁶ will be used.

Even with a cointegration relationship the validity of long-run relationships may be questioned, as standard econometric inference may not apply: in the long run first differences are expected to be zero, differencing will yield no long-run solution. In order to meaningfully incorporate a long-run relationship in a $I(0)$ regression, one can include an error correction term in any dynamic model. This term will be the estimated residuals in the Engel Granger cointegration test. Using this we have an Error Correction Model (ECM), that allows to study the short and long run dynamics of the series.

Having only 27 observations it is not possible to include many variables in the model. Furthermore this restricts the analysis considerably: even though several econometricians advocate that the frequency is not as relevant as time span, a time span of 27 years is considerably short and these test results should be taken lightly. Su Zhou, (2001) predicts that frequency can improve the power of the test, compensating in some way the lack of long-term information. Nevertheless, although

⁶ MacKinnon, James. 2010. "Critical Values for Cointegration Tests". Queen's Economics Department Working Paper No. 12

the data in this case is annual and the conclusions are limited, an attempt to study this relationship was made using standard econometric approaches.

Assuming that inequality cannot influence age distribution, (at least directly), this analysis will be made by a comparison with average benefits, as it is the only channel for it to influence SSEP size. Furthermore proportion of old people will influence total expenditure by age distribution, but it is of interest to understand if it has a direct influence on average benefits. This analysis will therefore be limited to three variables: average benefits, gini index and proportion of old people in the population.

The first step is to run the regression:

$$9) \text{Benefits}_t = B_0 + B_1 \text{Gini}_t + B_2 \text{Prop_old}_t + u$$

Then estimate the residuals u :

$$10) \hat{u} = \text{Benefits}_t - B_0 - B_1 \text{Gini}_t - B_2 \text{Prop_old}_t$$

And perform Dickey Fuller test with James G. MacKinnon critical values for cointegration. The following table summarizes the tests:

Residuals	Test Statistic	1%	5%	10%	Conclusion
Constant	-1.2830299	-3.9001	-3.3377	-3.0462	Unit Root
Trend	-1.176489471	-4.3266	-3.7809	-3.4959	Unit Root

Table 10: Cointegration test for Average benefits, gini index and proportion of old people

There is no evidence of cointegration between the 3 variables. Nevertheless it is still possible to have this long-term relationship between Gini index and average benefits.

The previous exercise was then duplicated using only these 2 variables. Again there was no evidence of cointegration:

Residuals	Test Statistic	1%	5%	10%	Conclusion
No constant	0.132691225	-2.5658	-1.9393	-1.6156	Unit Root
Constant	0.190793307	-3.4336	-2.8621	-2.5671	Unit Root
Trend	-1.414016794	-3.9638	-3.4126	-3.1279	Unit Root

Table 11: Cointegration test for Average benefits and gini index

Given this scenario ECM cannot be performed. Furthermore the fact that there is no

cointegration relationship between the variables suggests that they are not causal variables. But again these results are not final as the time span is insufficient.

To further analyse this, the normal step would be to analyse the variables in a multivariate scenario, this would fall in the scope of Johansen maximum likelihood method. Although it would be interesting to attempt an estimate of a cointegrating vector (any vector that multiplied by a set of variables yield stationary results) in this case it is believed that there is not sufficient information to do a satisfactory analysis and therefore none of that sort will be attempted.

One more attempt was made to test this theory: the Granger causality test. The test can be defined as a predictive causality test: the underlying question is whether one variable is a good fit for forecasting purposes. Again note that data limitations shorten the scope of conclusions. A bivariate Vector autoregressive model was run and the

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
gini	av_pension	3.1385	3	0.371
gini	ALL	3.1385	3	0.371
av_pension	gini	.83569	3	0.841
av_pension	ALL	.83569	3	0.841

optimal lag length was set as 1.

Output tables can be found in annex.

Each row of the table represents a

Table 12: Granger Causality test

Wald test with null that the coefficients of the lagged variable on “excluded” column are zero. The “equation” column represents the dependent variables. In this case all tests fail to reject the null and therefore gini index does not appear to Granger cause average pension benefits.

No statistical support was found to prove income distribution theory. It appears that although APB follows the same path as Gini index they do not have a significant causal relationship.

6 – Conclusion

The purpose of this Project was to identify which Public choice theories better contribute to explain the Portuguese SS expenditure. This understanding is crucial to

better comprehend which solutions to the Social Security problem would better fit its reality.

So, as to resolve this problem, one (or several) of the following should happen: a high enough increase in birth rates in order to shift demographic tendencies; significant productivity increase; increase in SS contributions rate; APB reduction; increase in retirement age and/or Social Security privatization, (that could only be politically achieved with high levels of public debt). Not only are most of these solutions impossible to implement, (as they are a result of many factors over which policy making has no or little power to influence), some of the outcomes of this solutions are not transparent.

Turner's theory states that the increase of the dependency ratio would lead to an increase of total SSEP, but this impact would be softened by the decrease of Average Pension Benefits. Nonetheless this model had no statistical support, as there is no evidence that old age dependency ratio has a negative impact on Average Pension Benefits over Income: both share an upward tendency. This implies that population ageing, at least until this point, has had only a positive impact on SSEP.

Income growth "theory" points out that income growth leads to a more than proportional increase of SSEP. As a consequence productivity increase would have a dual effect: on one hand it would led to an expansion of SS revenues but total expenditures would also increase. However it appears that, in Portugal, this statistical relationship has as basis population ageing. This means that considerable productivity gains would have much more impact in SS finances than it would given the existence of such causal relationship.

In the scenario that income distribution theory applies in Portugal, people would value not only intragenerational but also intergenerational redistribution. In the case of an

empowerment of the Social Security third pillar for instance, intergenerational redistribution losses would hold increased opportunity costs. Nonetheless, distribution is not one more obstacle to privatization, as no statistical relationship between inequality and APB was found.

From the hypothesis studied, demographic shifts appears to be the sole contributor to the increase of expenditure with pensions, and therefore policies directed to this problem should be implemented and strengthened.

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